# THE OFFICE AS AN INFORMATION PROCESSING SYSTEM:

# A CONCEPTUAL MODEL AND METHODOLOGY FOR FIELD STUDY

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THE OFFICE AS AN INFORMATION PROCESSING SYSTEM:
A CONCEPTUAL MODEL AND METHODOLOGY FOR FIELD STUDY

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## PREFACE

Office technology is creating changes in how office work is organized and where it takes place, whether in office buildings, in homes, or in moving vehicles. Organizing office work to make the most effective use of the new office technology requires a more fundamental understanding of the work being performed there than the usual activity oriented models by which we have divided the labour in the past.

This report provides a descriptive model of office function as an information processing system. It describes a coherent set of concepts designed to give a perspective on the office which will be meaningful in an environment using information processing and communications technology. The report also describes a practical methodology for measuring the functioning of any specific office and demonstrates application of the method in two different organizations. The process of relating the measures of office function to effective design of the automated office is not addressed in this report because it will require further study before the relationships can be drawn clearly. A number of recommendations are made for fruitful direction of study.

### The Model of Office Functions

The model described in this report was developed from an application of information processing theories to the offices. Information processing theories are based on the premise that a person extracts information from the environment and transforms it to make it useful for decision making. The model of office function is based on a similar concept. Each individual in the office extracts information from the environment which includes other people and transforms it for use by another person.

The model does not focus on activities such as typing and filing and time spent on them. Instead it considers what communications of information are necessary for a worker to perform a transformation task. Any activity which does not increase, or modify in some way, the information that the office worker is communicating to other people is not properly part of the work-related activities of the office.

This conceptual framework allows an economy of description. Only the most important activities are recorded. The conceptual model not only indicates what should be measured and analyzed in order to describe any one office but provides a framework for comparing different offices.

## The Measurement of Office Functions

The report also describes a methodology which directly measures the set of information processing activities outlined in the model. In a short, practical interview format, data can be collected about communications between people in an office which are relevant to its function.

The methodology was applied to two different organizations, one much more highly automated than the other. The description of its use provides a demonstration of how the methodology can be used to assess the state of the office on a technical-social continuum which can then be used to guide the implementation of automation.

A by-product of the demonstration was the finding that the more highly automated office was also the more socially oriented of the two. This is not sufficient to allow conclusions to be drawn about the effects of office automation in general. It does indicate that the presence of office automation will not necessarily stifle social interactions in the office.

## Behavioural Research in Office Communications

This is the third in the series of behavioural research reports prepared for the Office Communications Systems Program of the Department of Communications. The series is designed to provide intense focus on particular areas of concern where questions need to be more clearly articulated, the state of the art reviewed, or new concepts and methods of study developed. The reports are intended to be useful both practically to those installing or working with office communications technology and to researchers wishing to push forward tne frontiers of knowledge of human response in office technology environments.

This report will be practically useful to those implementing operational office technology. It introduces them to a view of their own environment and provides a methodology for further analysis of that environment which could lead to design of a more effective organization. The links between the model and effectiveness of the organization are still to be proven but the perspective and methodology are promising.

The report will provide researchers with a coherent research framework for asking questions and a method for answering them and comparing their work with others using the same framework and methods. It also provides recommendations for further exploration of the domain.

Since this report was prepared, a summary of the model presented here was published: Bavelas, A.; MacGregor, J.; Safayeni, F.; Office Automation: A Conceptual Approach, Journal of Information Science, 5, 1983, 169-172.

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# INTRODUCTION

As the work of this project has advanced, its relevance to the office of today and its implications for the office of tomorrow have become more and more obviously dependent on the validity of its two basic assumptions:

- the process of organizational control is the aspect of office activities that will be most significantly affected by the emerging information technology; and
- the analysis of an office system will be most rewarding if the properties of its components -- human, mechanical, or electronic -- are reduced to the same system-relevant terms.

All organizations exist in a continually changing environment. In the interests of effective planning and cost reduction, it is clearly advantageous to minimize the magnitude, variety and rate of the changes to which the organization must respond. Organizations usually attempt to achieve this control in two ways: by acting directly upon the environment outside the organization, and by establishing variety detection and control functions inside the organization. An important part of such internal systems is the information processing done in offices.

The office, whether it is regarded as an ubiquitous organizational function or as a set of geographically localized units, each dealing with a special category of information, has as its principal function the transformation of informational inputs into outputs suitable for managerial decision making. As the magnitude and complexity of this task have grown, so has the need for more efficient methods of processing information, and an impressive new technology is developing in response to this need. The automation of selected office activities is now becoming commonplace.

If this automation of information processing follows a course analogous to that of other industrial automations, the potential of the new equipment will probably be underutilized for some time, and in the most instances it will be uncomfortably lodged in offices organized for the performance of very different routines.

One objective of this project is to develop methods for obtaining the information needed to ease the discomforts of this interim period, and for making office adaptation to new equipment smoother and more productive in both the human and technical senses. A second and more ambitious objective is to explore the questions that will arise in the designing of the office of the future. Just as the hulls of ships using sail-power had to be modified to make efficient use of mechanical propulsion, so will the organization of the office be redesigned to make effective and efficient use of the new information systems. And just as in the case of the conversion of ships from sail to power, the implications for the organization and maintenance of office personnel will be deep and far-reaching.

Because of the challenges surrounding the office of the future, this research was planned along the lines suggested by the second assumption stated above: that the analysis of office functions will be most useful if the human components of the system are expressed in variables and terms compatible with those employed in information and communication engineering. This idea is not new -- it was a major ingredient in the successful attack on the man-machine problems that became so prominent during World War II.

Why did this breakthrough in dealing with human factors in system design come when it did? Complex equipment-operator problems had been around a long time before World War II. The most likely reason is that while machines were becoming more complex, the human factor was merely being explained in terms seldom useful to the designers of new machines. Explanations of the human factor in terms of personality types, or measures of mental rigidity, or machine-anxiety (which has cropped up again in modern dress as "cyberphobia") were based on conceptual systems that were, at best, of remote relevance to issues of machine design.

Although the methods developed for solving man-machine problems were originally applied to military issues, they were easily transferable to similar interface problems in industry. Experience with both military and industrial interface problems indicates that when human and mechanical components are working together in a single system, there will almost always be strong interactions between psychological and engineering variables. The successful exploitation of the interrelationship largely depends on dealing with mechanical and human components in the same realm of discourse.

This principle is easily applied to the single operator-machine situations that occur in offices. More interesting is the possibility that the same principle may be applied to an office group as a single organized entity. If there are performance characteristics of such organized groups that can be expressed in engineering terms, it may be possible to assess the compatibility of a particular human system with a specified machine system. With what success this possibility has been explored is discussed at length in Chapter 4.

## THE OFFICE AS A VARIETY CONTROL FUNCTION

The specific goals of this project were to develop laboratory and field methods for the study of the office. Before any work can begin in either of these modes of research, two questions must be answered: "What facts should be gathered?" and "What are the appropriate methods for gathering those facts?" These questions were resolved by adopting a model of the office implicit in the assumption stated earlier: that the activities of an office may be viewed as transforming input information into suitable output information. This model does not attempt to incorporate all possible activities of an operating office. Its contribution lies primarily in the economy of thought and empirical work that results from the ease with which working hypotheses can be eliminated. The model specifies that the performance of this function depends on the relationships between:

- the variety of the input information;
- the variety of transformations available to the office; and
- the desired degree of variety in the output.

Thus the model considers the office a variety-regulating system in which input variety is transformed into the desired level of output variety. The term variety refers to the number of possible states in the system and their associated probabilities.

One procedure that this model suggests is to consider the office as a "black box," and to focus on the state of the input information, and the state of that information when it becomes output, after being processed by the office. In these terms, the office activity constitutes its transfer function, relating the input to the output. In theory, a sufficient sampling of such transformations would yield an office transfer function relating the possible inputs to a distribution of outputs. This function would not need to be mathematical in the sense of a calculus. It might equally well operate on an input listing a set of conditions to produce an output that listed all instances satisfying those conditions.

While this is a practical way to determine the transfer function of a mechanical or electronic black box, applying the method to the office is of doubtful usefulness. The approach was abandoned because of three serious difficulties:

- In the case of a physical component, since it can, presumably, be manufactured to a set of specifications, the function obtained can be used in various systems with confidence. The black box "office," however, is a construct referring to a population of offices, no two of which might be very much alike. Thus, obtaining a transfer function that would be useful in other than the situation in which it was derived would require the study of a prohibitively large sample of offices.
- Deriving a transfer function requires accurate quantitative measures of the input and output variables. It is clear, however, that the informational inputs to an office cannot be adequately described by simply counting its different elements — so many letters, so many phone calls, so many reports, etc. Further, categorizing them into types does not help. Messages practically identical in form do not necessarily convey the same information; the urgency that is understood to be associated with a message is often not stated in the message itself. And a special relevance that a particular message may have to the office's current activities is seldom found in the objective input.
- The third and most serious difficulty is that a significant part of the variability that the office may have to deal with might reflect the internal operations of the office itself.

The conclusion is that the black box must be opened and its components and their interrelationships examined. For the field studies, therefore, an appropriate method might consist of interviewing, and directly observing the activities of, the persons in the office. Correspondingly, in the laboratory studies a group of persons would be assembled, the activities to be performed by each member of the experimental group would be imposed, and the consequences on variety control then recorded.

This sounds as though the components of the office system are the persons involved in the process. But, given the general orientation of this project, it seems more appropriate to define a component of the system as a transformational activity, operationally distinct from others, and serving as an input or an output (or both) to other components. Defined in this way, a component might involve only one person or the interaction of several persons.

Therefore, the description of an office, whether it be one observed in the field or one constructed in the laboratory, would be undertaken at two levels:

- a description of the task structure, consisting of the transformation components and their relation to each other, regardless of how they are distributed over individuals; and
- a description of the personal-interaction structure, consisting of the patterns of personal interactions related to task performance.

This argument leads to the model of the office proposed in this report:

- the office functions most likely to be radically altered by technical information-processing devices are those involved in the control (usually the reduction) of variety;
- the formal task structure of an office consists of the specification of transformation procedures -- defined above as components -- and the way in which they relate to each other;
- the allocation of these procedures over the set of persons constituting the office personnel determines certain necessary interactions between them;
- the required personal interactions are elaborated and varied, eventually stabilizing in a social structure that facilitates (or impedes) objective performance, and serves as a stable "social habitat" for the persons in it;
- the social structure, in turn, modifies the intended formal task structure into the one actually used;
- changes of the formal task-structure that result in changes of the existing social structure may evoke an effect whose valence and referral will depend on local context.

To understand this model, we must examine the input and output variety of the office and its transformational activities.

(a) Input and output variety. Input variety may be external or internal. The external variety has its source in the environment surrounding the office, which may be other parts of the organization or the environment outside the organization depending on the structural location of the office within the organization.

Internal variety is generated by the office itself in the process of transforming the external variety. It may be generated as the result of errors, co-ordination problems, personnel issues, and so on. One significant aspect of internal variety is that it challenges a "black box" approach to the office -- a model based on the relationship between input and output variety. Internal variety is also a useful indicator of the effectiveness of the office design.

The input variety of the office cannot be measured independent of its transformation activities, since most offices collect input into categories of similar items. In other words, perception of variety in the office is not independent of the variety-handling mechanisms available.

The output variety of the office is usually less than its input variety. This reduction of variety or removal of uncertainty is the control function of the office. The extent to which it can successfully exercise this function depends on the "closeness of match" between the input variety and the transformational activities.

(b) Transformational activities. These activities regulate variety in the office. Each component of an office system is defined as a transformational activity, operationally distinct from others, and serving as an input or an output (or both) to other components. Defined in this way, a component may involve one person or the interaction of several persons.

Based on this definition, the task structure of the office can be described as consisting of transformational components and their relation to each other, regardless of how they are distributed over individuals.

The task structure, as a network of interrelated tasks, necessitates interaction between persons on job-related matters. These personal interactions are elaborated and varied, eventually stabilizing in a social structure that facilitates (or impedes) objective performance, and serves as a stable "social habitat" for the employees. The relationship between the task structure and the social structure is a two-way one: the former operates as a constraint for the development of the social pattern, and the latter modifies the intended formal task structure into the one actually used.

The strength of the social structure depends on the extent to which mutual adjustment is needed to achieve co-ordination between related transformational activities in the task structure. In other words, different task structures lead to differing degrees of dependence between people. These differences may be viewed as a single continuum, one end of which is called technical and the other social. At the technical end lies a co-ordination process in which standard rules and procedures control the relationship among transformational activities. At the social end we find a co-ordination process in which the related transformational activities are regulated by mutual adjustment between persons.

A task structure co-ordinated by a technical process is a predictable system in both its input variety and the necessary transformational activities. Moreover, the relationships between people are also specified; their expectations in the social structure are based on formal rules and procedures. This machine-like system, although it may be efficient, is likely to produce a work environment in which human judgment and initiative are not welcomed, the social structure is weak since co-ordination has been standardized, and people are likely to irritate each other if they deviate from the prescribed

performance. Needless to say, a social co-ordination process will produce a very different work environment, in which people have the opportunity to help each other as well as creating difficulties.

These descriptions of technical and social co-ordination systems are extremes: most offices will tend to be somewhere along the continuum. The question is whether a given office is generally oriented toward one or another end of the continuum.

This conceptual model of the office aims to understand the effects of office automation in terms of changes in the task structure and corresponding changes in the social structure.

The methodology for studying the office directly follows from the model; it is designed to collect information on task variety, task connections, dependent task connections, and social structure.

## FIELD STUDIES

### Analytical Approach

The variety transformations of an office can be examined from different levels of analysis; the level appropriate in a particular situation will depend on the nature of the question being asked. For example, variety transformations may be associated with functions of the office as a whole, with functions of departments and groups within an office, or with individual functions. Emphasis has here been placed on performance characteristics of the office as a whole, and of groups within an office. This emphasis on performance at the supra-individual level suggests certain parallels between the approach taken here to office automation, and the socio-technical approach to industrial automation.[1] Some preliminary discussion of these parallels may help to place the field measures recommended here for use in office settings in a more general theoretical context.

A major goal of the socio-technical approach to innovation is to successfully integrate the "technological system," consisting of machines and standard procedures, with the "work organization" of people performing tasks. The argument put forward is that while technical requirements of new equipment may limit the available types of work organization, it may nevertheless be possible to adapt one or both systems in order to maximize their mutual "goodness of fit." Attention has tended to focus on the work organization, perhaps because it is considered to be the more flexible of the two systems. The significant characteristics of the work organization are (a) the work interdependency existing between people performing tasks, and (b) the social characteristics of groups formed on the basis of task interdependencies.

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[1] See, for example, Emery, F.E. and Trist, E.L. "Socio-Technical Systems," from Management Sciences: Models and Techniques, Vol. II, 1960, edited by C. West, Churchman and M. Verhulst, Pergamon, London.

There are certain reasons to believe that task interdependencies affect the introduction of automated procedures into offices. One reason is that task interdependencies reflect the division of labour and patterns of co-ordination, both formal and informal, whereby an office actually achieves its overall functions. Introducing automation in a manner that is "kind" to this existing system is likely to reduce the disruption of functions during the changeover period. Secondly, task interdependencies provide the context for the development of performance-related social relationships among personnel. Here the issue is not so much one of friendship patterns as of work-related interactions that allow for mutually supportive behaviours and exchanges with respect to task performance. A work-related social structure is therefore one in which expectations exist concerning such exchanges. If procedures are introduced in a manner that destabilizes these patterns of expectation, adverse consequences may result.

In developing field methods for studying the effects of automation, we have therefore concentrated on methods for identifying task interdependencies and assessing task-related social exchanges.

Task Interdependency

While we could postulate that all tasks related to a single output must be interdependent, we have concentrated here on adjacent dependencies. A dependency is considered to exist whenever the performance of one person can directly affect the performance of another. In serial dependencies, the output of one individual represents the input to a second, and the rate, quantity, ease or satisfactions associated with job performance of the latter depend on performance characteristics of the former. There are also parallel dependencies, where similarity and proximity of operations allow for mutually negotiated redistribution of load or exchanges of task-relevant information and skills. This relationship again allows for effects on the rate, quantity, ease and satisfactions of performance.

Test of the Procedure

It is clear that information about such dependencies cannot be obtained from inventories of office activities, which provide essentially static descriptions of behaviour. For this reason we devised an interview procedure to obtain the following information:

- the activities seen as regular parts of a job;
- the events that initiate an activity;
- the operations performed in the course of an activity;
- the nature and destination of outputs from an activity;
- the people contacted in the course of an activity;
- the perceived interchangeability of personnel;
- subjective estimates of the percentage of total time devoted to an activity.

The procedure has been tested in a field setting. Twenty-eight employees of a government agency were interviewed individually. They represented almost the entire agency staff below the level of senior management. In eight cases two interviewers recorded the data as a reliability check; single interviewers conducted the remaining sessions.

A directed graph for each activity proved to be a useful technique for recording a subject's responses. This graph was sketched as the subject spoke, and subjects were free to comment on the appropriateness of the representation. Interestingly, as the diagram developed it frequently brought to mind connections not initially mentioned.

General Findings

The general findings are described in terms of (a) relationships between individuals, (b) relationships between sections, (c) work flow through the office, (d) informal procedures, and (e) transactions at the boundaries of the agency.

(a) Relationships between individuals. (i) Clerical staff: When listing contacts made in the course of an activity, clerical staff tended to mention by name only other clerical staff working in the same section (with whom they shared a parallel dependency), or their immediate supervisor. The generality of this was one clear indication of fairly well-defined boundaries between sections within the agency. As further evidence of such boundaries, clerical staff discussed their transactions across section boundaries in terms of sectional names, even when probing indicated that they were aware of the names of individuals within those sections. This strongly suggests that the social structures of this group fall within section lines. One interesting exception to this has arisen in connection with the use of word processors. These machines are situated in "neutral" territory, and bring together clerical staff from different sections. Since little formal training with the machine is supplied, informal assistance and training are provided by the more experienced users. This is a case where the introduction of automated equipment appears to have augmented the existing social structure. Clerical staff were in favour of the machines themselves, but they expressed frustration at the organization's perceived failure to provide them with sufficient training to take advantage of the machine's capabilities.

(ii) Management staff: Whereas clerical staff reported dealing with job difficulties by discussion with their supervisors, management staff tended to enter into informal discussions with peers as a means of resolving problems or gaining additional information. Important factors in this exchange appeared to be geographical proximity and similarity of functions. Any procedural changes that resulted in increased specialization within this group would therefore be likely to reduce the basis on which these interchanges presently take place. One psychological barrier that may limit exchanges of this kind is the perceived pressure of work, such as the burden of clerical work that management staff report being required to perform. Procedural changes that reduced this pressure might facilitate the supportive interchange functions.

(b) Relationships between sections. As previously mentioned, relationships between sections were reported in corporate terms rather than as connections between individuals. Nevertheless, it was clear that social task dependencies

existed between sections, and difficulties arising in one section from the loss of a file, for example, or an incomplete form could create problems in an adjacent section. The extent of problems between sections may well be reflected in the number of transactions that occur in a direction opposite to that specified by the formal pattern of work flow. These included requests for clarification, information and changes in the work completed by the earlier section in order to permit processing by the later section.

(c) Work flow through the office. We were able to reconstruct the office work flow from the "parts" described by individuals. In its larger features this representation corresponded closely to a flow chart later provided by the organization. This reconstruction was made by the interviewers without any previous knowledge of the organization, and provided a representation of the main features of the office and of its functions that the individual interviewers would not have been able to provide.

The main difference between the official organizational flow chart and the reconstruction was that the latter showed more connections between sections. It also indicated the presence of two-way connections where the former showed only one-way connections. The reconstruction was also more detailed, in that it described transactions within sections as well as between them.

(d) Informal procedures. The interview method brought to light a number of informal procedures, some of which have already been mentioned. Others, which cannot be classified in detail at the present time, indicated important informal mechanisms for dealing with external agencies that facilitated the overall performance of the organization. Any changes in procedure that blocked these informal channels could result in a relatively sudden decrement in the office's achievement of its goals.

(e) Transactions at the boundaries of the office. In addition to a description of the internal dynamics of the office, the data portrayed the office's relationships with its environment. Information about inputs from

other government departments and the consequences of unacceptable outputs provided a clear picture of the overall functions of this particular office. These functions were regulatory in nature, aimed at consolidating government procedures into a set of standard practices. Failure to successfully accomplish this goal could lead to formal appeal procedures, which are extremely costly to the organization. Thus to some extent the organization's performance can be measured in terms of the number of formal appeals against its decisions, for they indicate the amount of unacceptable variety that the office failed to transform. This unacceptable variety may be generated by the departments that the office services, by the office itself, or by ambiguous government policies.

Given the office's function, it was bound to have an adversary relationship with the departments serviced. This also became apparent from the comments of interviewees, where examples were given of attempts "to pull the wool over our eyes."

A detailed version of this variety reduction analysis of the office's functions has been presented to its senior management, and proved to be an understandable and acceptable description of their function. Their readiness to accept the analysis suggests at least a degree of face validity for the theoretical constructs.

Our next task is to identify and collect empirical measures of input, output and self-generated variety. The number of transactions against the work flow, in the form of requests for clarification, changes in format, etc., may be fairly useful in estimating both input and self-generated variety. Output variety, as mentioned previously, will be reflected in the proportion of cases that are appealed. If these variables can be measured, we can derive realistic measures of overall office performance, and then incorporate them in before-and-after studies of the effects of automation.

Information of this kind may be too sensitive politically to be collected from government agencies, but more readily obtainable from private sector organizations.

**The Work-related Social Structure of an Office**

When work-interdependencies are present there may occur exchanges of supportive behaviours that go beyond the purely formal requirements of job performance and may have social and emotional value for the persons involved. To what extent such activities contribute to an informal social structure will partly depend the degree to which this behaviour is expected of employees. Since work dependencies provide the context for these exchanges, any procedural changes that modify work dependencies may also influence supportive behaviours and upset established patterns of expectancies.

Effects of this kind may be difficult to anticipate, since expectancies develop around informal rather than formal aspects of job procedures. If formal job requirements include supportive behaviours, fulfilling those obligations need not carry "excess" social information. But where behaviours depart from formal expectations -- either positively or negatively from the point of view of someone dependent on those behaviours -- the departures may have a social or emotional significance.

It is important to emphasize that procedural changes may have positive or negative consequences to an informal social structure. Such changes may either remove or create task dependencies, which may be contexts for both positive and negative social exchanges. As described above, in one case automation created parallel task dependencies that produced generally positive exchanges.

If informal work-related social structures depend on exchanges and expectations about exchanges, they may be regarded as values shared by individuals or groups. One procedure for identifying such values, previously used in a variety of social settings, may be applicable here.[2]

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[2] See Kalhorn, J. Values and sources of authority among rural children, Iowa University Studies in Child Welfare, Vol. 20, 1944. See also Barthol, R.P. and Bridge, R.G. "The Echo Multi-response Method for Surveying Value and Influence Patterns in Groups," Psychological Reports, 1968, 22, 1345-1354.

The method consists of the following main steps.

- A sample of individuals is obtained from the population of interest.
- They are provided with the valence (positive or negative) associated with a behaviour and asked to provide instances of behaviour having that valence which can or do occur in a particular context. (Past experience indicates that the precise wording of the instructions is important, and some pilot testing may be required to secure an appropriate phrasing. For example, a positive valence could be assessed using the question "In doing your job are there things that other people in the office do that are helpful to you, and that you appreciate?")
- Subjects are asked to list a number of valued behaviours, both positive and negative, and to indicate the sources of those behaviours.

The procedure was employed in the field-setting used in testing the measure of task-dependency. Some possible patterns of results are discussed below.

Individual sources of positively and negatively valenced behaviours are likely to be people mentioned in the context of task-dependencies, while the section sources of valenced behaviours will have been mentioned as sections in the context of task-dependencies. In other words, there should be some correlation between the pattern of task-dependencies and the pattern of socially valenced behaviours. Individuals will probably be mentioned more frequently than sections, because social exchanges are expected to develop around informal procedures, which are often associated with people as individuals.

If a correlation of this kind is found, it will represent a measure of convergent validity of the measures and of their conceptual under-pinnings. If the data also reveal either potent or stable sources of social exchanges, this social pattern should be taken into consideration in adopting procedural changes.

If no correlation was found between task-dependencies and social structure, it could indicate problems with either one or both of the measures or their conceptual basis. Alternatively, the social structure could be extremely weak or unstable. Weak social structures develop where behaviour in task-dependent situations is governed by formal mechanisms because there is no basis for the growth of a task-dependent informal social structure. Unstable social structures, in contrast, are characterized by inconsistent or idiosyncratic values, relecting an absence of commonly held expectation; such situations arise when, for example, an organization is undergoing a series of changes.

A number of analyses are possible with social value data of this kind. One interesting approach is to determine whether positively valued activities are associated with refraining from certain behaviours while negatively valued activities are associated with performing certain behaviours. This pattern is often found in a highly regulated, legalistic environment and may indeed be typical of certain bureaucratic organizations. Data of this kind would be important in interpreting a lack of correlation between task and social dependencies, should that arise.

**The Field Study**

The field study discussed here -- covering task-dependency, overall input-output functions, and social structure -- may provide a conceptually related set of measures for evaluating the impact of automation at different levels of office functioning. To do so, the measures must be applied in before-and-after designs.

The original plan of the project was to conduct a before-and-after comparison study of an office in the process of adopting electronic equipment. It later became apparent that the office under study (Office A) would not automate quickly enough to allow such a comparison to be made within the time limits of the present project. The office currently has several WANG word processors, one systems analyst, and only one employee who operates the equipment on anything approaching a full-time basis. The automation of office functions is still at an early stage.

To obtain some comparative data we selected a second organization whose office had been highly automated for the last three years. In this case all office personnel were equipped with word processors and used them as a matter of course in their daily work (an estimated average of 50 per cent of the day was spent at the machines). The sample of subjects had been using the equipment for an average of 18 months, which was close to their total period of employment with the company (on average 20 months). Compared to Office A, Office B was both highly automated and already beyond the initial stages of automation.

Office A is part of a provincial government central agency whose main function is to regulate certain aspects of public service employment. The agency employs about 100 people. Office B is part of a private manufacturing company that assembles computer terminals. The company is approximately 3 years old, has 110 employees, and distributes its products to markets in Canada, the United States and Europe.

The measures taken in each office were approximately the same. However, some procedural changes were made in studying Office B, mainly because of access constraints, and it will simplify exposition to present the results separately for the two offices before comparing them.

Hypotheses

The terms "technical" and "social" have been used to describe two connecting mechanisms between related tasks in an organization and the reader should bear in mind the particular sense in which the terms are being employed here. It is the existence of social as well as technical connections between tasks that is considered to give rise to task-dependent social networks.

The theory leads to a number of hypotheses.

Hypothesis 1: Changing the types of connection between tasks will influence the task-dependent social network. Specifically, changing a social to a technical connection will tend to weaken social links (not necessarily bad, of course, if the social link produced a negative effect). Changing a technical link to a social link will strengthen social networks.

Hypothesis 2: The greater the relative frequency of technically-mediated connections, the weaker will be the social structure of the office and the more salient will be technical concerns as a perceived means of attaining task performance. The greater the relative frequency of socially-mediated connections, the stronger will be the social structure and the more salient will be social concerns as a perceived means of attaining task performance.

Hypothesis 3: As task variety increases, the more necessary mutual adjustment will be as a means of achieving co-ordination, and the more social connections between tasks will exist. As task variety decreases, the opposite effects will occur.

The idea has been expressed that advanced automation may reduce the variety in the content and organization of office activities. If this idea is correct, certain specific predictions can be made about the comparison between Office A and Office B:

Prediction 1: There will be greater task variety in Office A than in Office B.
Prediction 2: Social connections will be relatively more frequent in Office A than in Office B.
Prediction 3: Social rather than technical concerns will be perceived more frequently in Office A than in Office B as factors influencing task performance.
Prediction 4: Morale will be higher in Office A than in Office B.
Prediction 5: There will be fewer criticisms associated with electronic equipment in Office A than in Office B.

**Office A - Method**

Subjects

The study of Office A was carried out in two stages separated by a period of several weeks. The first stage consisted of individual interviews with 28 employees; in the second stage, 31 employees completed questionnaires. For our purposes it was necessary that a subject participate in both stages of the

procedure. Unfortunately, this occurred in only 15 cases. Of these, three subjects were relatively new employees whose position in the organizational hierarchy was difficult to determine. Consequently most of the analyses have been conducted with n = 12.

Procedure

A task analysis was conducted with each subject during a 30- to 60-minute interview. Structured questions were used to discover:

- the number of main activities carried out in a job;
- the percentage of total time spent on the main activity;
- the people that the subject normally interacted with in the course of an activity.

Subjects then completed questionnaires on task dependence in a group setting. Two questions were asked:

- What could someone do that would make it easier for you to do your job well? Who could this be?
- What could someone do that would make it more difficult for you to do your job well? Who could this be?

Subjects were asked to give 18 responses, 9 positive and 9 negative. Positive responses were written separately on white cards, negative responses on red cards.

Results and Discussion

To test the hypotheses and predictions presented earlier it was necessary to obtain from the data measures of (a) task variety, (b) social connections, (c) social and technical concerns in achieving task performance, (d) morale, and (e) criticism associated with electronic equipment. For the present we will be concerned with the first three of these measures.

(a) Task variety. Two questions were pertinent to task variety, the number of main activities associated with a job and the percentage of total time spent on the main activity. Since the greater the number of main activities the less time will be available for any one of them, there should be a negative correlation between the measures. The relationship therefore provides a way of checking the interreliability of the two estimates.

We would also expect some relationship between an individual's rank in the organization and the level of task variety.

Lower-level clerical positions would be expected to have lower task variety than higher-level administrative positions. This relationship would again offer a means of checking the validity of the measures. Government classification of positions was used as the measure of organizational rank. Table 1 below shows the intercorrelations of the three variables.

**Table 1**

**Correlations of number of activities, percentage of time on main activity and organizational rank**

| | No. of Activities | Percentage of Time | Organizational Rank |
|---|---|---|---|
| No. of activities | | -.50* | .81* |
| Percentage of time | | | -.67* |

* $p < .05$, one tailed test

All the correlations were in the predicted direction, and significant beyond the .05 level. Number of activities and percentage of total time will therefore be employed here as our measure of task variety.

(b) Social connections. In the task analysis interview subjects provided the names of people that they normally interacted with in order to complete an activity. These responses represent the set of task connections for an individual.

Connections may be either technically or socially mediated. In the former case some kind of technical or procedural mechanism is in place to regulate what occurs at the connection. In the latter case the individuals themselves regulate the relationship, either because one or both deviate from the technical constraint or because no such constraint has been established.

Notice that where an effective technical or procedural standard exists and where the people involved meet that standard, one cannot affect the task accomplishment of the other: the co-ordination is achieved automatically. Only when standards are inappropriate or when people deviate from them or when no standards exist can one influence the job performance of the other. (There is one exception to this, when one person has the authority to change the standards and thereby influence performance. This special kind of social connection, the "power connection," will be discussed later.)

In general, however, where it is possible for one person's job performance to influence the job performance of another, the connection between those jobs is not effectively mediated by technical means. It is at these points that mutual adjustment and negotiation can arise.

If this reasoning is correct, socially-mediated connections exist only when (i) a connection exists and (ii) task performance can be influenced across that connection.

The task-dependency questionnaire identified individuals who were sources of influence on task performance. The subset of these with whom the subject also shares a task connection will therefore represent relationships that meet the necessary conditions for a social connection. (Notice, however, that the set may also include power connections.)

As a preliminary measure of social connection we have therefore taken the intersection between the set of task connections and the set of task dependencies. A social connection is considered to exist when a subject reports a person who is both connected with, and perceived as an influence on, task performance.

At this point we can examine the validity of both the theory and the measures by testing Hypothesis 3, which stated that as task variety increases the number of social connections will increase. If this holds true, the number of social connections should increase with number of activities and organizational rank, and decrease with the percentage of time spent on the main activity. Table 2 shows the correlations.

**Table 2**

**Correlations of numbers of social connections with number of activities, percentage of time and organizational rank**

| | No. of Activities | Percentage of Time | Organizational Rank |
|---|---|---|---|
| No. of social connections | .69* | -.41 | .67* |

* $p < .01$

All the relationships were in the predicted direction, and two of the three were significant. This provides some support both for Hypothesis 3 and for the measure of social connection.

(c) Social and Technical Concerns in Task Performance. Subjects' responses to the questions "What could someone do that would make it easier to do your job well?" and "What could someone do that would make it more difficult for you to do your job well?" allow us to examine the particular focus of perceived influences on task performance. Were the expressed concerns more with procedures, training, job descriptions, documentation and other "technical" characteristics of task performance, or more with interpersonal relations, morale, conflicts, co-operation, influence, and other "social" aspects of performance?

To measure the relative frequency of each type of concern, three judges classified each of the 306 responses into one of three categories -- "technical," "social" and "undecided" (for those cases where a judge felt no clear decision could be made). The judges worked independently, and the entire procedure required three to four hours to complete.[3]

The first concern is with the interreliability of judgments. Each of the three judges classified responses into three categories, giving 3 x 3 x 3 possible allocations for any one response. If the judges allocated responses randomly, they could have reached unanimous agreement three ways out of the possible 27. Under this condition there would have been 34 unanimous agreements. The obtained number, 154, was far in excess of chance expectation ($z = 21.7$, $p < .01$). A less stringent criterion of agreement is that no response should be judged as displaying a technical concern by one judge and a social concern by another. Using this "no contradiction" criterion the level of agreement increased to 275 responses, about 90 per cent of the total.

The proportion of "undecided" classifications was small under both criteria of agreement (around 10 per cent), and these responses were ignored. The remaining responses had all been judged as displaying either a technical or social focus. An overall "technical orientation" score was obtained for each subject from the ratio (number of technical responses)/(number of technical + social responses).

A measure of this kind allows us to test Hypothesis 2, which stated that the greater the relative frequency of technical to social connections the weaker will be the social structure and the greater will be the emphasis on technical concerns as a means of achieving task performance. The hypothesis really addresses an office as a whole, but it may apply at an individual level, in which case we would expect a negative correlation between the number of social connections an individual has and that individual's overall "technical orientation" score. The obtained correlation was in the right direction, but weak ($r = -.23$, n.s.).

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[3] See Appendix B for a sample of technical concerns and Appendix C for social concerns.

One problem here may be in the measure of social connection. We mentioned earlier that the definition of the measure allowed for the inclusion of a special class of relationship in which one individual has authority over another. Such an individual can exert an influence over task performance directly, by altering the technical standards of performance. Therefore connections of this kind do not necessarily signify the presence of mutual adjustment or other socially-mediated influences at the points of connection between tasks. We tried to remove these relationships by excluding social connections involving a superior, resulting in a "peer social connection" measure for each subject. The correlation between this measure of social connection and individuals' technical orientation score was $r = -.54$ ($p < .05$).

A related problem with the social connection measure may have arisen because of the particular wording of the question--"What could someone do...." Because of this hypothetical slant to the question, subjects described both real and what appeared to be conjectural events, from statements like "Mr. X could and does give overly detailed instructions..." to "They could take my typewriter away." The more conjectural types of responses frequently seemed to cite a person in authority as the source of influence. Since this may have resulted in an inflated measure of social connection, particularly for lower-level employees, the questions were reworded in the study of Office B.

## Office B - Method

### Subjects

Office B was studied in one stage, during which seven employees were interviewed individually. As in Office A the employees occupied junior or senior clerical positions and administrative support positions.

### Procedure

The interview questions are reproduced in Appendix A. The task analysis questions addressed were:

- The number of main activities carried out in a job.

- The percentage of total time spent on the main activity.
- How long it would take a person with the necessary technical skills, such as typing, to learn the job.
- The people that a subject normally interacted with in the course of an activity.

The task dependency questions asked:

- What does someone do that allows you to do your job better, and who is it that does this?
- What does someone do that does not allow you to do your job better, and who is it that does this?

Results and Discussion

The data were again used to develop measures of (a) task variety, (b) social connections, and (c) social and technical concerns in task performance.

(a) Task variety. In addition to number of activities and percentage of time spent on the main activity, subjects were asked how long it would take someone who already had the necessary technical skills to learn their job. This provided three measures potentially related to task variety. Since it was difficult to determine the organizational rank of these subjects the variable of rank was omitted.

Table 3 shows the correlations among the three variables.

Table 3

Correlations of numbers of activities, percentage of time, and time to learn the job

| | No. of Activities | Percentage of Time | Time to Learn |
|---|---|---|---|
| No. of activities | | -.79* | .35 |
| Percentage of time | | | -.36 |

* $p < .05$

All the relationships were in the expected direction, though only the correlation between number of activities and percentage of time on main activity reached significance. These two measures will again be used as the measures of task variety.

(b) Social connections. The number of social connections for a subject was again measured by counting the number of connections who were also cited as sources of influence on job performance. This allowed a second test of Hypothesis 3, that as task variety increases the number of social connections will increase. Table 4 presents the relevant findings.

**Table 4**

**Correlations of the number of social connections with number of activities, percentage of time and time to learn the job**

| | No. of Activities | Percentage of Time | Time to Learn |
|---|---|---|---|
| No. of social connections | -.02 | -.30 | .38 |

The results provided little support for the hypothesis. The first correlation was zero, and while the remaining two were in the predicted direction, neither reached signficance.

(c) Social and technical concerns in task performance. As in the previous study, the content of subjects' responses to the two task-dependency questions allowed us to examine the particular focus of perceived influences on task performance. Did the concerns tend to have a technical or social orientation?

Subjects' responses were classified at the same time as those from Office A in a blind procedure, so that judgments could not be influenced by knowledge of which office had generated them. The levels of interjudge reliability were almost identical to those obtained for Office A: the judges agreed on 24 of the 48 responses. When the criterion was widened to include all non-contradictory judgments, the level of agreement rose to 90 per cent.

As before, an overall "technical orientation" score was obtained for each subject by taking the ratio of technical responses to total responses. This permitted a second test of Hypothesis 2, which stated that there will be an inverse relationship between the degree of technical orientation and the number of social connections. Once again the results were almost identical to those for Office A. The correlation between the proportion of technical concerns and the number of social connections was in the predicted direction, though non-significant ($r = -.30$), but when social connections involving a supervisor were removed to give a measure of "peer social connections" a stronger relationship with technical orientation emerged ($\underline{r} = -.75$, $p < .05$).

General Discussion

The results for both Office A and Office B provided some support for the hypotheses tested. Task variety increased, the number of socially-mediated rather than technically-mediated task connections increased somewhat, and as the number of socially-mediated connections increased, social rather than technical factors were reported more frequently as factors affecting task performance.

The significance of these relationships for office automation will depend on whether they tend to be systematically affected by the introduction of automated equipment. Where task variety is high, social connections may be important mechanisms for accomplishing tasks. If automation systematically tends to replace social with technical connections, the result could be an overall reduction in performance levels and standards.

The extent to which automation itself is <u>necessarily</u> associated with such effects is therefore an issue of some concern. A comparison between Office A and Office B cannot logically prove any necessary connection between advanced automation and reductions in task variety and social connections. It does, however, provide an opportunity to <u>disprove</u> that any such necessary association exists.

**Comparisons Between the Offices**

Office A is still in the early stages of automation. By comparison, Office B is at a much more advanced level of automation.

If office automation necessarily leads to reductions in task variety, and to the replacement of social with technical connections, certain predictions can be made concerning expected differences between Office A and Office B. Specifically:

Prediction 1: There will be greater task variety in Office A than in Office B
Prediction 2: Social connections will be relatively more frequent in Office A than in Office B.
Prediction 3: Social rather than technical concerns will be perceived as factors influencing task performance more frequently in Office A than in Office B.
Prediction 4: Morale will be higher in Office A than in Office B.
Prediction 5: There will be fewer criticisms of electronic equipment in Office A than in Office B.

These predictions were tested and the results are reported below.

Results

Prediction 1: There will be greater task variety in Office A.

The prediction can be tested by comparing the mean number of activities and the mean percentage of total time spent on the main activity as reported by subjects in each office. Table 5 shows the means for the two measures for each office.

**Table 5**

**Task variety measures**

| | Mean No. of Activities | Mean Percentage of Time |
|---|---|---|
| Office A | 5.17 | 52.92 |
| Office B | 3.71 | 50.43 |

The difference between mean number of activities for the two offices was in the predicted direction, but failed to reach significance ($t = 1.65$, $p > .10$). The difference between mean percentage time was also non-significant ($t = .22$, $p > .10$), and in the direction opposite to the prediction. The results failed to support Prediction 1. There appeared to be no reliable differences in task variety in the two offices.

Prediction 2: Social connections will be relatively more frequent in Office A than in Office B.

Table 6 shows the mean number of all social connections and the mean number of peer social connections for the two offices.

**Table 6**

**Mean numbers of social connections and peer social connections**

| | Mean No. of Social Connections | Mean No. of Peer Social Connection |
|---|---|---|
| Office A | 5.67 | 2.00 |
| Office B | 6.29 | 3.14 |

There were no significant differences between the means for either measure ($t = .45$ and $t = 1.14$, respectively, $df = 17$). In addition, the differences both ran counter to the predicted direction. Because of this, we examined social connections in the two offices more closely, by investigating the

relationships between the number of task connections, the number of task dependencies, and the number of social connections. These results are shown in Table 7.

**Table 7**

**Numbers of task connections, task dependencies and social connections**

| | No. of Task Connections | No. of Task Dependencies | No. of Social Connections |
|---|---|---|---|
| Office A | 207 | 251 | 72 |
| Office B | 93 | 51 | 44 |

If set C represents all task connections of a subject and set D the task dependencies, then set CnD represents the social connections.

Next, if we consider that employees' relationships within the office consist of both people that they are connected with and people that can influence their task performance, the set of relationships is given by CuD. The number of elements in this set is given by $C + D - (CnD)$.

The extent to which a person has social connections within this set of relationships is given by $(CnD)/((C + D) - (CnD))$. The measure reflects the extent to which the person is "socially connected" to the set of perceived relationships. As the ratio approaches 1 it indicates that the employee has social connections with almost everyone in his or her set of perceived relationships. A ratio of almost zero means the employee has very few social connections relative to the number of perceived relationships.

A relative measure of this kind avoids problems associated with differences in the number of connections and dependencies between the two offices. When the two offices were compared using this measure a significant difference was found. The mean ratio for Office A was .25, and for Office B, .59 ($t = 2.81$, $df = 17$, $p < .02$, two-tailed). The result contradicted the prediction that subjects in

Office A would have a relatively greater number of social connections than subjects in Office B. In fact, the latter had more social connections. Prediction 2 was therefore rejected.

Prediction 3: Social as opposed to technical concerns will be perceived as factors influencing task performance more frequently in Office A than in Office B.

The prediction was tested by comparing the frequencies of social and technical statements about influence on task performance for the two offices. The results are shown in Table 8.

**Table 8**

**Reported technical and social influences on task performance**

| | Technical | Social |
|---|---|---|
| Office A | 127 | 12 |
| Office B | 5 | 18 |

A Chi-square test indicated that the frequencies of cell entries were significantly different from chance (Chi-square = 63.4, $p < .01$). Again the differences obtained were in the direction opposite to the prediction. Office B rather than Office A reported social influences on task performance relatively more frequently. Prediction 3 was therefore rejected. (This comparison was carried out using responses that judges had classified unanimously. Using the no-contradiction criterion of agreement the same pattern of results emerged, with a Chi-square value of 51.8, $p < .01$.)

Prediction 4: Morale level will be higher in Office A than in Office B.

No specific questions were asked concerning morale. However, since subjects provided both negative and positive instances of influences on task performance, it is possible to compare social influences of a positive and

negative type for the two offices to get some idea of the relative levels of morale and to compare positive and negative statements about equipment from the two offices (Table 10). Examples of positive social influences were given in the statements "Openness and willingness to give information about what's going on" and "Trust from employees and supervisors while doing liaison work." Examples of negative social influences were "Someone keeps interrupting me at whatever I'm doing..." and "Too much squabbling and fighting in the office." (A complete list of these statements is given in Appendix C.)

The frequencies of positive and negative statements are shown in Tables 9 and 10.

**Table 9**

**Frequencies of positive and negative social influence statements**

| | Positive Social Influence | Negative Social Influence |
|---|---|---|
| Office A | 5 | 7 |
| Office B | 17 | 1 |

**Table 10**

**Frequencies of positive and negative statements about equipment***

| | Positive Statements | Negative Statements |
|---|---|---|
| Office A | 5 | 26 |
| Office B | 5 | 0 |

* All the statements are reproduced in Appendix D.

**Discussion**

Field studies rarely provide the best means of testing a hypothesis. In this case, however, certain predictions were tested from what might be called the "pessimistic theory" of office automation: that advanced automation will

necessarily be associated with job-impoverishment, reduced social connections, an emphasis on technical concerns, lower morale and a rejection of the equipment that brings this about.

The study compared two offices, one in the very early stages of the introduction of equipment and one at a much more advanced stage. None of the results from these offices supported the predictions. On the contrary, the more automated office turned out to have a significantly greater number of task-dependent social connections, significantly more social influences on task performance, significantly higher morale, and significantly fewer criticisms of electronic equipment. Clearly, the presence of equipment per se need not be associated with negative human and social factors.

The pattern of results was entirely consistent with the interviewers' subjective impressions of the two offices. Both were busy, but in Office A the "busyness" seemed frequently to be associated with feelings of tension and irritation. Relationships with other employees seemed to be sources of dissatisfaction as frequently as satisfaction, an impression confirmed by the data. There was little evidence of enthusiasm. The "busyness" of Office B, in contrast, seemed to be associated with high levels of motivation and willingness to help others. Inverviewees mentioned that if they were finished their own work they would ask others if they needed assistance, and this strong emphasis on helpful relationships shows up clearly in the task-dependency statements (see Appendix C).

The attitudinal "climate" in Office B extended to the use of the electronic equipment. Every subject mentioned the usefulness of the machines and their reliance upon them. Interest in the use of the equipment was high; one clerical employee even expressed a desire to learn about the hardware involved. The clerks viewed the equipment creatively, working with the systems analysts to develop the software needed for their administrative procedures. The systems analysts were highly regarded for their accessibility and willingness to provide assistance.

Some impression of the differences in the subjects' experiences with equipment can be gained from their statements. Table 11 gives a classification of all the equipment-oriented statements from the two offices.

**Table 11**

**Frequency of types of statements about electronic equipment**

| Statement | Office A | Office B |
|---|---|---|
| Lack of access | 15 | 0 |
| Lack of training | 5 | 0 |
| Need for more equipment | 3 | 0 |
| Following specific procedures | 3 | 0 |
| Supportive role of specialist or other operator | 1 | 4 |
| Other | 4 | 1 |

It should be noted first of all that no statements from either of the offices were critical of the machines themselves. The large number of negative statements from Office A were directed rather towards implementation and use. There was in fact a widespread interest in using the machines, probably stimulated by the presence of several machines in the building. Because of an apparent shortage of terminals, however, there were many grievances about the lack of machines, the problems of scheduling time, and the inequities in allocating use.

Many employees in Office A also complained about a lack of training. Interestingly, employees in Office B had no more formal training than many of the employees in Office A. The difference seems to be in the context of training. Employees in Office A mentioned special workshops mounted by the suppliers of the equipment. In Office B training was provided on the job, with continuous access to the equipment.

It is impossible from a field study of this kind to reach firm conclusions about what may lie behind the differences between the two offices. However, a number of factors may bear upon the apparent comfort with which Office B makes use of its electronic equipment.

- The company produces terminals: the executives and managers themselves use and understand the equipment. Introduction of equipment is from the "top down", rather than from the "bottom up" as in Office A.
- The company is relatively new, and administrative procedures are still being developed. The office staff themselves are instrumental in developing such procedures, and interact with the systems analysts to get appropriate software outlined.
- Employees have ready access to the systems analysts, who are perceived as helpful and informative.
- Employees are concerned with how to use the equipment to facilitate their tasks. This attitude is probably supported by the fact that their ideas frequently appear to be implemented.
- Employees have continuous access to their own equipment. This provides them with experience, and avoids the problems of access so apparent in Office A. It also builds the equipment into the job, rather than "building a job around the equipment." This latter trend was already apparent in Office A, where the term "word-processor operator" was frequently used. There is no such specialized function in Office B.

These and other observations provide the basis for some recommendations, which are developed below.

**General Recommendations for Implementing Office Automation**

The growing interest of many organizations in the area of office automation has given rise to practical concerns regarding implementation, and it is not unusual to hear the failures of an office automation project explained in terms of bad implementation procedures.

The following practical recommendations stem from our observations of office automation.

- Use the methodology discussed in this report to assess the state of the office on the technical-social continuum.

- The closer the office is to the social end of the continuum, the greater is the need for employee participation in designing and implementing the "new" office.
- Find out what the job-person dependencies are and try to preserve them after machine installation.
- Assess the units' dependencies on related units where the secondary effects of machine introduction may make the difference.
- Set objective and attainable goals for achievement throughout the transitional period.
- Make equipment available on a non-work basis.
- Avoid installing too little equipment for staff needs.
- Make programming and debugging a participative function.
- Budget for adequate training of the operators.
- Ask quick learners to help the slow learners.

## TOWARD AN EXPERIMENTAL PROGRAM

An experimental program not only has inherent methodological advantages, but also serves as a useful complement to the field studies. In the course of field interviews and observations, hypotheses regarding the process being studied normally arise but are sometimes very difficult or impossible to verify. They may, however, be easily disconfirmed in the laboratory. Conversely, in the experimental investigation of an arranged office structure, observed relationships between variables may suggest important new questions to ask in the field studies.

In addition, the requirements of the experimental method have a salutary effect on hypotheses that cannot be adequately represented in experimental terms. The concepts involved must be clarified and expressed in variables susceptible to concrete operations.

Two possible targets for experimental work stand out very clearly: studies of the effects on a single operator when the degree of variety in the input, in the transformational functions available, and the variety required in the output are varied systematically, and studies of structured groups working together in a single processing system, with selected distributions of variety across the system.

As single operator study designs resemble many partly standardized experimental set-ups for measuring individual performance, no unusual problems of procedure need to be solved. For this reason, we have devoted most of our time to studying structured groups dealing with controllable task variables.

In one interesting type of study, the total transfer function is distributed across a number of workstations, the exact distribution being under the experimenter's control. Systematic variations would permit observation of their effects on performance, including social and emotional changes. A general outline of an appropriate task follows.

Workstations are coupled in series, so that the output of one station forms the input for the immediately subsequent station. Each contributes to an overall "office" objective and also has local objectives. Transformational variety at each station can be increased or decreased either by changing the local objectives or by changing the local rules of operation. Because later operations depend on earlier ones, changing the transformational variety at one station has ramifications for later stations. It changes the task structure in a manner that can be objectively specified.

A formal analysis has been done on a simple version of the task, where the input to Station 1 is a sequence of numbers generated randomly from an array consisting of the numbers 1 through 4. The objective at this station might be, for example, to obtain numbers totalling 5. Totals that exceed 5 form the input to Station 2, where the task is to draw numbers until their total plus the input total from Station 1 reaches, say, 10. Totals in excess of this form the input to Station 3, where the process is repeated with a new target, for example a total of 15. Totals in excess of this represent errors of the whole system, and can be subtracted from the number of initial input numbers (at Station 1) to give a measure of the overall performance of the "office." Local performance may be measured by the relative frequency with which local targets are met.

This is, of course, a machine system in the sense that there are no decisions to be made, and, barring errors of addition by subjects, local and overall outputs are completely determined by the input numbers. Nevertheless, this simple form of the task has some interesting characteristics that are relevant to the hypotheses being tested.

The first point of interest is that the probabilities of reaching a target are not equal across workstations. Station 1 has the lowest probability of attaining its local objectives, while Station 3 has the highest. This is one simple aspect of the task structure that may influence social relationships. However, of more interest is the reason why these differential probabilities arise, for this provides an insight into the relationship between the work-stations.

Station 1 receives a rectangular distribution of numbers from the source, receiving on average an equal number of ones, twos, threes, and fours. Ones are the most useful, since they can lead to the local target in a number of different ways. Fours are least desirable, since there is a high likelihood that they will result in overshooting the local target on the next draw.

However, because of the first station's processing the input to Station 2 is not a rectangular distribution of sixes, sevens, eights and nines. Rather, the input is biased in favour of lower values, making the task at Station 2 relatively more successful than that at Station 1.

A similar attenuation of input variety occurs at Station 2, making Station 3's task the most successful of all.

Significantly, the input variety to later stations depends on the processing done by earlier stations. Thus the entire task-structure system can be manipulated by changing the transformational variety at a particular work station.

One technique for changing transformational variety at a station is by "widening" the local target. This permits the station to successfully absorb more of the input variety, and reduces the output reaching the subsequent workstations. However, the precise effects of this depend somewhat on the direction in which the target is enlarged. For example, the target at Station 1 might be widened to encompass totals of 4 and 5, or to encompass totals of 5 and 6. In both cases performance at Station 1 improves, as does the overall performance of the system. However, they are far from equivalent changes, in that they lead to quite opposite effects at Station 2. A target of 4 or 5 at Station 1 improves performance at Station 2, since it leads to an increase in the probability of reaching the local target. In contrast, a target of 5 or 6 at Station 1 has a detrimental effect at Station 2, reducing the probability of reaching the local target. If our hypotheses are correct, these two types of change -- superficially very similar -- will have quite different social and emotional consequences for the system.

Changes in variety-attenuating capacities at workstations are quite likely to accompany the introduction of machine-processing into an office. In the kind of task outlined here, changes in task structure can readily be correlated with the introduction of a machine process at a workstation. Under such circumstances, subjects will probably attribute any negative consequences of change in task structure to the machine, and not to the true variable, the change in task structure brought about by the redistribution of transformational variety through the system. Conversely, the positive effects of redistribution may also be attributed to the introduction of the machine process. In either case, if reactions to machine processes can be systematically associated with changes in task structure, the results may have some useful implications for the introduction of machine processes in office systems.

Experiments along these lines are quite feasible with respect to design and measurement, and they would no doubt deliver information directly relevant to the central concerns of this project. They do, however, have one very practical drawback that has effectively prevented us from working in that direction. To reveal the effects of changes upon the group's performance, the group must first be allowed to work at the task long enough to establish work habits and to develop a stable social structure. This is unlikely to happen during the typical two- or three-hour laboratory experiment. Also, since the laboratory subjects know that they are participating in an experiment, they will respond to the experimental variables in ways not typical of an established working group. One way to deal with these problems is to actually hire a number of persons to perform a task that looks like "real work," and to keep them at it for a couple of weeks before making changes and observing the results. Financial constraints prohibited such an approach, so we used a method that did not require a controlled history.

Reference was made earlier to the advantages of analyzing the behavioural properties of the human components in a hybrid system by employing variables and terms compatible with those employed in information and communication engineering. The question remained whether the methods successful in single operator-machine settings could be usefully applied to settings involving structured groups working with a machine system. We believe that this can be done.

In man-machine interface studies, a problem that has received considerable attention is the relation between a display, its controls and the performance of the operator. A special aspect of this problem was given the title "direction of motion stereotypes," which can be explained this way:

Suppose that an operator, who has a variety of tasks to perform, is required to move the pointer shown in the display to a required new position. The pointer can be moved by turning a knob. Will it make any difference whether the control knob is placed in the same plane as the display but either to the right or the left of it? See figures 1a and 1b. Inexperienced operators are practically unanimous in assuming that the control knob in Figure 1a should be moved clockwise to cause the pointer to go up. The same operators approaching the control box shown in Figure 1b will be equally unanimous in turning the control knob clockwise also in order to cause the pointer to go down. Such motion stereotypes are taken into account in modern equipment design, and the performance results are positive. Although operators can be trained to use controls quite well despite their violation of existing stereotypes, stress, overload and fatigue often lead to regression to the stereotype, sometimes with disastrous results.

Figure 1a

Figure 1b

It is important to note that this motion stereotype is not explainable in terms of the operator's visual or muscle systems. The behaviour in both situations is quite consistent: the operator expects the pointer to move in the same direction as that portion of the control knob closest to the display. The stereotype is a behavioural expression of a perceptual-cognitive model about how the two motions would be correlated in order to make sense.

There is evidence to suggest that such stereotypes exist when an individual structures a job.[4] That is, from the possible ways that a given job could be done, people tend to select one particular approach. The selected alternative tends to "unitize" the individual's job such that it corresponds to the structure of the environment and forms a task configuration in line with the Gestalt principles of organization. Moreover, for tasks with similar degrees of "goodness" of structure, people tend to select arrangements that maximize their experience of relative movement in the direction of the goal.

If a similar kind of perceptual-cognitive stereotype exists for the way in which groups tend to organize their related tasks, we might consider the effects on job performance when imposed task definitions and the task structures depart from the stereotype. The experimental procedure would consist of three steps:

1. The selection of an information processing job for which it can be shown that a stereotype exists. A group assembled in the laboratory is presented with a job consisting essentially of an initial state of information that cannot be transformed into a specified terminal state. The group is allowed to organize itself and do the work in any way that makes sense to them. The subjects are encouraged to try out their procedure and to modify it, if necessary, while they arrive at a version that is satisfactory for effective and efficient performance. If tasks and task structure stereotypes exist, they should be revealed by observing a relatively small number of groups. By judicious selection of the allocated job it should be possible to obtain this information within the time limits of a typical laboratory session.

2. The analysis of the job given to the experimental groups and its restructuring. The job will be broken down into a sequence of detailed step-by-step operations. These operations would then be assembled into specific tasks, and the tasks related to each other so as to form a task structure. Both the tasks themselves and the way they are related must satisfy two conditions:

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[4] Safayeni, F.R. "Topological Space and Work Situations," unpublished Ph.D. Dissertation, University of Victoria, 1979.

- as separate tasks and as a task structure they must differ radically from the stereotype that the groups developed by themselves, and
- they must form a system which is effective and efficient in doing the job.

3. The conducting of experiments in which a new set of groups experiences both methods of work. A new set of groups will be used in order to eliminate the possibility that the stereotype will be preferred because it was the group's own invention. The experiment will be some form of a cross-over design so that order effects can be assessed. Two kinds of measures will be taken:

- performance measures of quantity and quality of work done. Also evaluated will be the awareness of the group to errors in their operations, and their response to error, whether perceived internally or pointed out to them; and
- description and assessment of the social structure that emerges as a function of the different operating procedures.

We anticipate that a number of different kinds of jobs can be found to fulfill the requirements stated above. To clarify the possibilities of the proposed experimental design, we will explain one concrete example of such a job: the solving of a set of simultaneous equations. For simplicity, the number of unknowns and the size of the work group are assumed to be three. Also, although the same problem -- the solving for the unknown -- may be presented in various formats, in this description we will assume that the three equations making up the set are presented to the group as input.

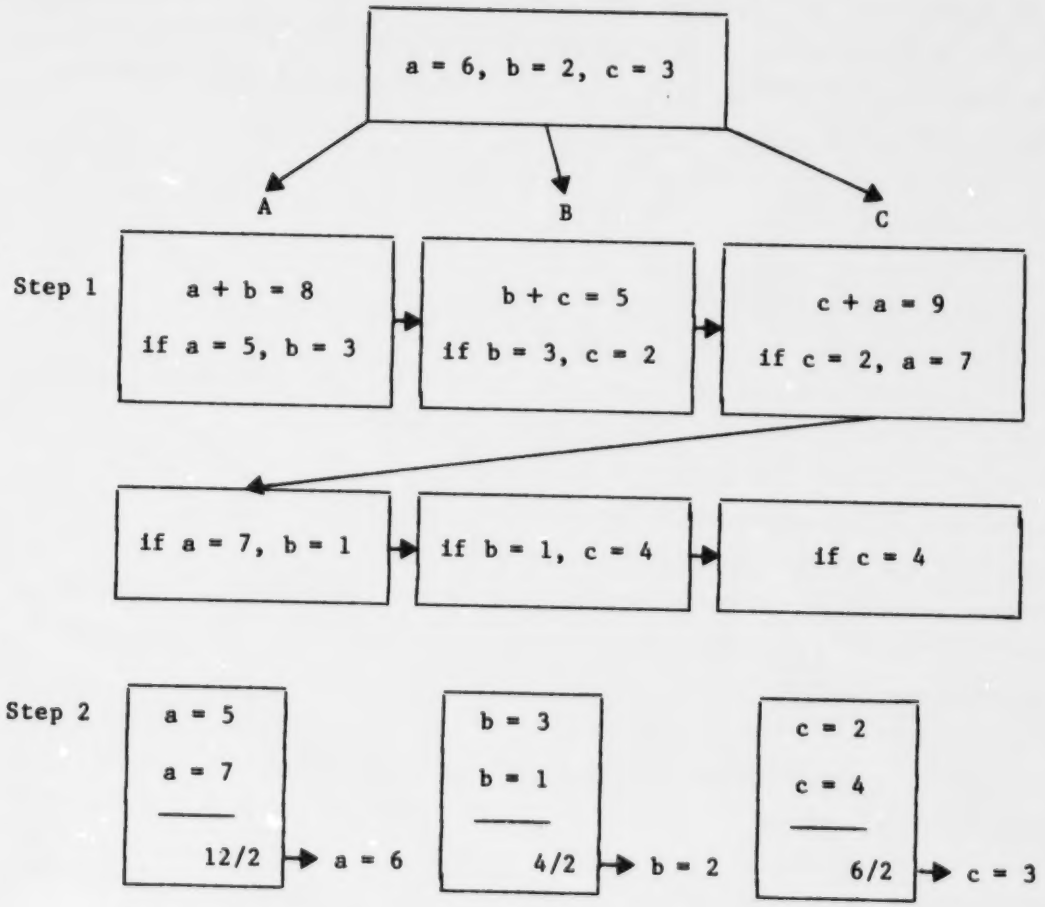
Our subjects will know, or at least dimly remember, the solution procedure to be used. The groups in step 1 of the experiment -- from which we expect to derive the stereotype -- will be given some practice sets of equations and told to organize so that they will be able to produce correct answers at as high a rate as possible. The importance of accuracy will be stressed by instructions such as "Fewer solutions without error are of much greater value than many more solutions with even one error."

Even if no one in the group remembers the standard procedure for solving simultaneous equations, it will probably be recovered through discussion and by trial-and-error. Once the method is clear, its logic is likely to determine the structure of the operation. Let us assume that the arrangement adopted by the majority of groups is a parallel process. That is, each person will independently solve a set of equations. Thus, when the job begins in earnest, each person will take a card listing three equations -- $a + b = 8$, $b + c = 5$, $c + a = 9$ — obtain the values for the variables, and go on to the next card in the input box.

The second step in the experiment requires the devising of a process that is adequate for doing the job but lacks the attributes of the stereotype. One such process would be as follows:

- Each of three persons is assigned the responsibility of obtaining the correct value of one of the variables.
- Each person is given one of the three equations, so that each person has an equation in which the variable for which he is responsible is mentioned.
- The solutions are obtained by a sequential process: the solver for variable a assumes any value he likes for the value of a, records it, solves for the value of b and sends that to the person responsible for finding the value of b; he records that received value, enters it into his equation, solves for c and sends that to the person responsible for the value of c. This cycle continues with a feeding of a new value of a to the first person until each subject has two recorded values for this variable. He then averages the two, the result being the value of the variable. The group then tests the answers by substituting them in the three equations given to them. If the answers check out, they report the answers and go on to the next set. A graphic presentation of this process is shown in Figure 2.

**Figure 2**




Step 1. A assumes any value for a (in this example, 5) solves for b and sends this value to B. B accepts this value for b, solves for c and sends it to C, etc.

Step 2. As soon as two values, including the one originally assumed, are obtained, their average is computed and is always the correct value for each variable.

What can we expect from a group of persons who have this method of work imposed on them? They are unlikely to understand why the procedure works. Each person will know what he or she is doing, but why it makes any sense will remain obscure. A more serious consequence is that under certain circumstances they will be unaware that they have not obtained the correct values -- because the obtained values check out all right when substituted in the equations. In contrast, the group working under the first method will know if they have made an error and also the reasons for it. A comparison of the process and awareness of error is shown in Figures 3 and 4.

Apart from the issue of internal awareness of error, an experiment of this kind would yield evidence on the validity of the model proposed earlier in this report: that the task structure is an important determiner of the social structure, and that it tends to modify operating procedures.

In none of the experiments described or presently envisaged is it expected that actual office machines will be employed as experimental variables. This is not an oversight. We have simply assumed that the essential aspect of any office machine is the application to a set of inputs of a set of processes so that a desired mapping of the imputs is produced at the output. This effect can be approximated to a desired degree (except for speed) in various ways -- for instance, a set of forms that will accept only a specified set of inputs, a list of operations to be applied to those inputs, and a set of forms for the presentation of results. In a series of exploratory experiments it is easier to change or adapt such simulations of machines than to reprogram the real thing, and much less expensive.

**Figure 3**

$(a = 6,\ b = 2,\ c = 3)$

**First method:**

$a + b = 8$ $\qquad$ $b + c = 5$ $\qquad$ $a - c = 3$

by subtraction:

$$\begin{array}{rl} a + b & = 8 \\ -\ (b + c) & = 5 \\ \hline a - c & = 3 \end{array}$$

but this was known already, therefore, the third equation was redundant.

The solver in this group would know something was wrong, and it would be soon evident that a correct value for the variables could not be obtained.

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**Figure 4**

**Second method:**

| $a + b = 8$ | $b + c = 5$ | $a - c = 3$ |
|---|---|---|
| if $a = 5,\ b = 3$ | if $b = 3,\ c = 2$ | if $c = 2,\ a = 5$ |
| if $a = 5,\ b = 3$ | if $b = 3,\ c = 2$ | if $c = 2,\ a = 5$ |
| $a = 5$ | $b = 3$ | $c = 2$ |
| $a = 5$ | $b = 3$ | $c = 2$ |
| $10/2 = a = 5$ | $6/2 = b = 3$ | $4/2 = c = 2$ |

If these values are substituted in the equation, they will check out OK!

## SUMMARY

The office is considered an information processing system that transforms input variety into suitable output variety. The process is accomplished by the requisite variety of the office which controls variety. The main advantage of such a conceptual framework is that it allows human behaviour and office technology to be analyzed with the same language. Moreover, the generality of such system concepts readily lends itself to the analysis of events at different levels.

The transformational variety of the office is considered in terms of a network of task dependencies distributed among the employees. This network of task dependencies operates within the context of a social structure that evolves around the task structure, and, in turn, modifies certain operations within the task structure.

Given the conceptual model, the methodology for studying offices directs its questions to the task interdependencies and the accompanying social structure. The appropriate methods of raising these questions are discussed within the context of field work and it appears that both the conceptual scheme and the proposed methodology are suitable for studying the dynamics of office activity and for evaluating the effects of introducing a specified new technology.

The problems of studying office automation are explored in terms of possible laboratory experiments. The experimental program complements the field studies by its efficiency for testing hypotheses and by raising new questions of significance for field studies. One line of interest is experimental work directed toward the study of "stereotypes" in groups for organizing related parts of a job. The existence of such stereotypes raises questions about the extent to which they correspond to the group's cognitive-perceptual stereotypes, and the effects of deviations from stereotypes on the performance and morale of the group.

## FUTURE RESEARCH RECOMMENDATIONS ON LABORATORY AND FIELD EXPERIMENTATION

The major objective of our work has been to understand the automated office of today and the automated office of the future. Our method of gathering data has been the field study, primarily the interview and the echo technique described earlier.5

The information obtained in this way has lent support to hypotheses concerning the essential function of the office, the formation and nature of interrelationships, and the effects on such social structures of the degree of constraint embodied in the office procedures.

Despite this support, the generality of the model is not known, and cannot be tested by any feasible program of additional field studies. For example, the differences between the two offices studied in detail is striking; yet it is not possible to identify with any confidence which constellation of all possible variables in operation were responsible for the effect observed.

We have discussed in earlier reports the potential value of experimentation for the verification of conclusions drawn from field studies. At this time, the case to be made for investigations in the experimental mode is even stronger. Since the hypotheses regarding the "office" have been supported by the field studies, it is even more important to determine their validity and generality. Another reason for urging an experimental program relates to our second objective -- the "office of the future". This phrase implies an exploration of optimal arrangements of equipment and new, emergent forms of work organization. Such instances are not to be found in the field; they must be created.

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5 Barthol, R.P. and Bridge, R.G. The Echo Multi-response Method for Surveying Value and Influence Patterns in Groups, Psychology Reports, 1968, 22, 1345-1354.

Two kinds of experimental effort are recommended: the traditional laboratory setting in which the pertinent variables are either controlled or manipulated by the investigator; and the controlled field study, or field experiment. This is done in an operating organization, and some variables are manipulated in only some parts of the structure. This form of investigation has been widely used in industry and has demonstrated its value.

The choice between the laboratory or the field experiment depends on the objective to be served. When an essential aspect of a complex situation can be abstracted and effectively simulated in the laboratory, it may be possible to observe the effect of an isolated variable unobstructed by its usual concomitants. But everything depends on successfully capturing that essential aspect. When this is impossible, either because no single aspect can be taken out of the complex without losing its significance, or because simulating the entire complex would negate all the advantages of simplicity and observation, one would do better to study the naturally-occurring situation. Even then, however, it may be possible to go beyond observation, interviews and questionnaires to do a controlled field study, in which comparable groups or departments or offices can be studied under a designed change of procedure.

Although these controlled field studies lack a good deal of the precision and control achievable in the laboratory, they have proved valuable in many industrial applications. More important, they have merits of a kind not generally associated with laboratory studies. Since such field experiments involve an actual change in some part of an on going organization, the management is necessarily involved in the planning and execution of the change. By agreeing to the experiment, management declares itself to be interested in the results and expecting some benefit to the organization. This means that if a positive result is achieved, the implementation problem is half-solved. The findings of the study don't have to be "sold" to the practitioner -- something that is often a problem with findings from an abstract laboratory study.

On the basis of our present understanding of the essentially behavioural issues of office automation, the following studies are strongly recommended. For convenience, they will be grouped into laboratory and field experiments.

**Laboratory Studies**

Effects of the Distribution of Variety-transforming Capacity

This variable deserves study both as it affects the single individual, and as it affects a working group.

(a) Individuals. The variety-transforming capacity of a person can be considered to be the relation between the structure of categories into which he or she can sort inputs and the variety of the inputs received. One question that obviously affects the success with which an organization can adjust to a changing environment is the acuity of discrimination of its "sensory" units. If the perception of the person who deals with environmental inputs is affected by the categories to be used in interpreting that input, the direction and extent of that effect should be known. The advantages of doing such a study in the laboratory are obvious.

(b) Working groups. There is good reason to believe that performance, including social and emotional factors, is affected by the manner in which the total transfer function of a group is distributed across stations. The experiment described on pages 38 to 41 would be useful in investigating these effects.

Adaptability of Task Structure to Environmental Changes

Task structures may initially be designed to process inputs with certain characteristic distributions (in terms of amount, frequency, variety, error, etc.). These, together with performance characteristics of the individuals involved and environmental factors (such as time factors, budget, equipments, etc.), represent constraints within which an adequate task structure must be formed. As constraints change, a previously effective task structure may become ineffective, or a previously infeasible task structure may appear workable. Questions arise as to the responsiveness of a working group to changes of this kind.

Simple aspects of input that may change as a result of automation are the amount and frequency of information to be processed by an office. An experimental task that lends itself to studying the effects of these variables should require no special training, have low variability within individual performances, and be brief enough that many trials can be conducted during an experimental session. One such task is the following.

A group is presented with a sequence of random numbers. The length of the sequence and the rate of presentation are variables affecting load. The load is made sufficiently great initially so that no one individual is able to add the sequence. The group's task is to so organize themselves so that they are able to find the sum of the numbers. Over a period of trials, the group operates under different conditions of load. Reorganizations of the group are permitted at any point in time. Dependent measures may include:

- type of organization employed;
- changes in organization as a function of load and performance;
- number and location of errors;
- satisfaction and "morale."

Preliminary experiments have already been conducted with six five-person groups, with the following tentative results.

(a) Organizational choices. The number of different organizations employed between and within groups is small. Theoretically, the number of possible organizations is likely to be a very large number indeed, in the absence of any constraints. If the sequence consists of 30 numbers and there are five persons available, for example, there are initially five possible distributions of work load. Apparently, working groups do not make any initial effort to consider even a handful of these possibilities, but rather quickly agree on a method of organization. Various factors seem to severely constrain the types of organizations that a group will entertain. Some of these constraints apparently reflect limits on individual processing capacity, while others arise from the recognition of orderly relationships between properties of the input and properties of the group. For example, when the number of sequence items is

a multiple of the number of group members, equal distributions of load across individuals appear to be a compelling principle of organization. Where this does not pertain, groups may consider a wider variety of possible organizations, in one case appointing a "specialist" whose task was to study the input numbers. Groups may also use certain orderly characteristics of the input itself as a basis for organization. Groups know, for example, that the numbers are drawn from the array of single-digit numbers. In other words, they can predict the types of numbers that will appear. This results in some groups "specializing," one person being responsible for summing all ones and nines, for example, a second person for summing two and eights, and so on. Alternatively, since groups know in advance the number of items in a sequence, they allocate adjacent blocks of items to individuals in a way that will predictably exhaust the entire sequence.

We note that when an organization develops around some orderly aspect of the input, it may differentially sensitize the organization to changes in that input. If the sequence described above becomes non-random by changes in the relative frequencies of selection of numbers, this change is more likely to be perceived in the organization of "specialists", since individuals would notice changes in their own work loads. Yet if the sequence becomes non-random by changes in the transitional probabilities of adjacent items, this is more likely to be perceived in the organization where individuals memorize blocks of adjacent items. Thus the type of organization employed may enhance the perceptibility of certain input characteristics while unintentionally destroying access to information about other characteristics. Clearly, this would have consequences for an organization's capacity to respond to changes in input.

(b) Response to errors. A second tentative finding concerns groups response to errors. Errors were interpreted by groups in at least three distinct ways: that the organization was inappropriate and should be changed, that the organization was appropriate but further practice was required, or that the organization was appropriate but some individual member was at fault. This is of considerable interest, because it allows the possibility of studying in simple situations how organized groups respond to information about their performance. Questions arise as to whether differences in response depend on

the history of the group, previous success or failure, a priori ideas about the theoretical effectiveness of the organization, etc. One group, for example, persisted with a form of organization despite repeated failures, under the expressed conviction that the "system must work." Was it a characteristic of the form of organization that gave rise to this conviction? Other groups spent considerable time and effort to discover "who made the error," in one instance "demoting" the person they took to be the culprit. An understanding of the underlying principles of these differences in response would be of considerable practical as well as theoretical interest, since they are representative of the kinds of responses observed in "real world" organizations.

(c) Satisfactions. Groups may obtain satisfactions apparently uncorrelated with the success of a particular type of organization. These satisfactions may stem directly from properties of the work situation created by the method of organization employed. Thus internal perceptions of "good organization" may not depend on performance, and this may well affect the responsiveness of an organization to performance feedback.

If this kind of experiment were to be pursued, it would be useful to know in advance what kinds of organization were in fact feasible under specified sets of conditions. Knowledge of all feasible organizations would permit, among other things:

- observing which feasible organizations are never or rarely selected;
- testing the operating characteristics of such organizations by having groups employ them;
- developing and testing hypotheses about implicit constraints that may focus groups on particular types of organization.

A first step in pursuing this kind of experiment would be an attempt to specify analytically all feasible organizations. This would be possible by:

- identifying the psychological operations involved in the task (e.g., recognition of a number, storing it, recalling, adding, etc.);
- specifying which operations are "tied" (e.g., storing and recalling may not be distributed in two different individuals);

- identifying sequencing constraints (e.g., adding cannot occur prior to recognition);
- entering individual constraints (e.g., capacity limitations on amount and rate of processing).

Specification of these constraints would allow a program to be written that could then generate all feasible task organizations for given lengths of list and rates of presentation. Such a specification, together with a study of 20 or so experimental groups in action, would be a fruitful first step in exploring the potential of a task of this kind for testing hypotheses about the responsiveness of organizations to changes in their input environments.

The existence of an organization of interdependent tasks designed to perform some overall function or functions necessitates a flow of materials through the organization.

Organizational flowcharts typically represent this traffic as one-way. In reality, however, the forwarding of incomplete or inaccurate materials results in their return for reprocessing to an earlier workstation. Returns of this kind may increase the load at a particular station (and neighbouring stations) beyond what was planned for on the basis of a priori scheduling. This in turn may lead to further errors under pressure, and so on. In other words, system effects may occur within a work flow that depends on the interactions of functional relationships between workstations.

Measures of this kind would be extremely useful in the field for assessing both the transformational variety and the internally generated variety of offices.

Programmable and Unprogrammable Know-how

It is often cited, in anecdotal form, that the skill and the "know-how" that a machine operator accumulates over time is seldom possible to transmit completely by means of instructions and drawings. Information gained by experience is not all coded by the learner in terms that are easily communicable. Experimental studies have shown that when a skilled operator tries carefully

to produce "the whole story," significant parts of what he or she knows do not survive translation into English. It is not surprising that a programmer typically does not get all the information needed from detailed descriptions made by the person in an office to be automated.

An understanding of the causes of these communication failures and their avoidance might well lead to procedures more effective for obtaining complete and accurate statements of the processes to be programmed.

Introductory Programs

In one industrial study involving the introduction of automated machinery that would have great effects on the work organization and require the gaining of new skills, the following procedure was said to have been very helpful in cushioning the shock. The new equipment was installed in a separate space and was available in working hours and after work for employees to "play" with. It was not geared into production; it was just there to be viewed and "tried." This idea may have a potential worth exploring, especially if game-like programs are furnished. For example, there exists a program intended to improve typing skills that is organized along game lines: the "targets" are words that one can shoot down for a score by typing the words correctly. Introductory programs that embody the skills needed but have the game feeling in them could be written.

Perspective on Training and Debugging

The transitional period -- from the first installation to operational effectiveness -- should be set up in such a way as to allow for the positive effects of individual and work-group perceptions of success. This means that sub-goals of achievement, short of the ultimately desired level, should be clearly structured, and the information that indicates their achievement be objective and accessible.

It may be a very effective procedure for "getting up to speed" to use the existing social structure for a self-help arrangement by which faster learners help slower ones. Such an arrangement can have morale benefits as well.

**Field Experiments**

The introduction of new equipment into an established office goes through a series of phases, each of which poses questions that are possible to study in the field. These are:

Phase 1. The state of the office before feasibility studies are made. Use of the Echo technique in the two offices studied, indicates that its use will yield two important kinds of information: (a) the relative position of the office on the technical-social continuum, and (b) the work relationships that have developed in the group. The first item of information is a rough predictor of the extent to which the introduction of automation will require changes of job perceptions; the second item -- especially important if the group lies closer to the social end of the continuum -- shows the job relations that should be preserved, if possible, in the transitional phase at least.

Although the potential usefulness of the Echo technique has already been demonstrated, the various forms in which it can be applied should be explored.

Phase 2. Feasibility study.

Phase 3. Briefing the programmer.

These two phases are sometimes distinctly separate, sometimes blended. In any case, the extent and manner of employee participation can have strong effects on the stress of the change and the smoothness of adaptation. Numerous studies in industry support this view. A significant amount of the inevitable debugging may be due not to equipment problems but to the incomplete informing of the programmer. The production of a more accurate and complete picture of the processes involved in the office operation has been mentioned as a research project under the laboratory section.

## A FINAL NOTE

One aspect of the problem of the automated office is what has been called "the office of the future." This phrase may be taken to mean, simply, the fully automated office, or it may be taken to mean an optimal arrangement of advanced equipment with new, emergent forms of human organization. In the latter sense, it may seem that there is not much that can be done but to observe the changes and make the best of them. This reactive attitude would be a mistake, for this is exactly the time when some thought about foreseeable features and limitations could have a long-range positive effect.

Deliberately or inadvertently, technological structures are selected that affect for a long time how work shall be done and decisions made. But such choices tend to become strongly fixed in economic investment, productive processes and social habit, and the original flexibility at an earlier choice point vanishes, for all practical purposes. Whenever feasible, therefore, it would be prudent to examine alternative "offices of the future" before freedom of choice is effectively lost.

We are not merely proposing the production of speculative think-pieces -- alternative scenarios of the future. Rather, we are proposing the actual observation of the effects of "marrying" selected equipment alternatives with selected forms of human organization. New operational modes can be simulated by programming, and some of the organizational alternatives have been thoroughly explored in earlier reports. Such an "experimental office" could be used as a test-bed for questions of procedure too radical in nature to be tested in the field.

# APPENDIX A

## INTERVIEW QUESTIONS

1. How long have you been working here?

2. What is your position?

3. How long have you been working in your present position?

4. What are the main activities in your job?
(Explain with an example.)

5. What is involved in each activity?

6. Who are the people you interact with in the course of your activity?

7. a) How long does it take to complete the activity?
b) How frequently do you do this activity?

8. What percent of time do you spend on the major activity?

9. How long does it take for someone with necessary technical skills to learn your job?

10. Equipment
    a) What kind?
    b) How long have you been working with this equipment?
    c) How much use?

11. What does someone do that allows you to do your job better, and who is it that does this?
(Ask for 4 or 5 examples.)

12. What does someone do that <u>does not</u> allow you to do your job better, and who is it that does this?
(Ask for 4 or 5 examples.)

13. How many people in questions (11) and (12) are also in question (6)?

# APPENDIX B

## A SAMPLE OF TECHNICAL TASK DEPENDENCY STATEMENTS FROM OFFICE A

The speed and accuracy of reports, records, files, letters.

Applications no longer summarized or filed.

Not using fill-in forms for certain routine work.

Not having clerks check requisitions for all required information.

Providing incomplete or incorrect information on requisitions.

They could delay or incorrectly fill out monthly reports which would cause my final overall reports to be late.

Process not routed properly (i.e. misfiling of applications).

Maybe another card can be produced to fill in to people who don't have a yellow acknowledgement (form).

Have all the applications in the folder alphabetized.

Provide offer letters already prepared to standard format.

Central switchboard for screening and sorting out calls.

Update fileroom procedures.

Policies and procedures should be more clearly stated.

Consistent policy should be emphasized. New policy material should be distributed faster.

All invoices and travel vouchers could be checked and coded more accurately.

Clarify in specific terms actual duties to be performed in my position to ensure job being done completely and correctly from beginning to end.

Ensure that I receive bulletins and circulars dealing with my duties to be kept aware of changes, new forms, etc.

In and out boxes could be set up for typing in order of priority.

Approve 110's before they are sent to me, with all info included so I could match up quite easily.

Make sure that all memos are distributed to our office so we know the new rules to be applied to our job.

Ensure that all proper documentation are complete and in order before it is forwarded to me.

Provide a more comprehensive job specification manual for comparison to topic positions.

No employee number, birth date, or PMS number on appointment action forms.

Call in for status of a competition and have no information, i.e. competition number, closing date, Ministry.

To forget the PMS number of a requisition and A form.

Sending requisitions to me not signed or approved by the board.

Competition folders not in order; i.e. in and out of service not sorted.

Lost folders and/or competition-related papers are a big time-consuming problem. Persons responsible should keep a more close watch and not rely on clerical staff to find missing ones.

Organize filing system in a more logical way.

# A P P E N D I X C

## ALL SOCIAL TASK DEPENDENCY STATEMENTS

Office A

Argue within the office.

Lack of morale in office. Too much squabbling and fighting among staff.

Someone could (and does) keep interrupting me at whatever I am doing.

Stop all operators from using my room which presently contains the WANG system and printer as a chit-chat area while they are waiting to print.

Recognize the relative importance of the functions performed by my department and respond with positive support when improvements are suggested.

To have the Director available for consultation and decision making and provide leadership on a daily basis -- again for consistency and communication.

Allow me to take a more active role in the recruitment process (through) discussion with consultants.

They could get rid of our systems analyst who is a big help to me.

Decrease the amount of co-operation with regard to sharing equipment. We rely on co-operation to sort out priorities -- word-processor specifically.

The people within the organization do not get along well and co-operate.

If senior staff members were not respectful and polite in their requests for jobs they would like performed and finished on time.

Co-operation from the file room.

## Office B

Trying to persuade secretaries or clerks to get something done.

You can call on people for help. For example the president of the American branch took over the display booth for me.

If there are problems with the system (the systems analysts) are very helpful.

Co-operation and moral and physical support from the Director of --- who is very supportive.

Enthusiasm and attitude of getting the job done without worrying if it's in the job description.

Production Department really assist me in getting an order done in a hurry.

Accountant helps in taking care of shipping orders. Very helpful in giving information.

I will help accountant with researching shipping orders or with queries.

The systems analyst is very helpful if problems with the system. I call him if I need information and don't know which system to be in.

Helpful training and support on the job.

Co-operation of plant and customer services managers.

Marilyn will do copying for me if I'm busy.

I will do work for Al if Dianne's too busy, and help Dianne out with typing or copying. I know she will help me if I ask.

Openness and willingness to give information about what's going on.

Openness to questions. Can go to Dianne anytime and she will help.

Trust from employees and supervisors while doing liaison work.

When I am too busy Lillian asks to help me out.

Help on work from Dianne--she is a good person to have around.

# APPENDIX D

## ALL TASK DEPENDENCY STATEMENTS CONCERNED WITH ELECTRONIC EQUIPMENT

Office A

Advertising section could make my job easier by being sure the "distribution sheet" is correct when they bring it for us to process on the WANG. Quite a large number of changes take place which require getting into the document and inserting or deleting something -- again time consuming and interruptive.

Monopolize word processing equipment unnecessarily.

Not have WANG available for drafting initial stage of reports, etc.

Only put information, statistics, etc. into the computer and not have the information available therefore.

Supply my own WANG terminal and printer. I find it very frustrating to have to wait for access to the WANG.

The understanding and patience of all the people related to the word processor when it breaks down and work is piled up and takes weeks to be caught up.

All word processor operators could make my job more difficult by not checking if other operaters are using the system to file, by not being more considerate of the time alloted per person and by not making sure of taking care when system is full.

Reduced access to word processor.

Asking for a job to be completed in an unrealistic time period, which may cause me to have to bump people off the word processor so that I can complete the job on time. It puts me in an awkward position with the people I bump.

Someone could forget to provide me with Action forms: I will not do a procedure on WANG without it -- thus resulting in inaccurate information.

Wang so booked up cannot get on. Not enough machines.

Stop all operators from using my room, which presently contains the Wang system and printer, as a chit chat area while they are waiting to print.

Never given access to word processor.

Organize the operation of sharing the WANG workstations to avoid time wasted in confusion.

Come up with a more efficient and equitable time use for the word processing terminals.

Decrease amount of co-operation with regard to different sections sharing equipment. We rely on co-operation to sort out priorities (word processor specifically).

When Wang malfunctions in some way I couldn't fix it myself and I could have no help.

They could buy more word processing equipment.

Be allowed access to word processor and to operators for various kinds of jobs needing done on processor.

Instruct all other word processor operators on filing, resetting, making and editing glossaries, etc. so that they would be able to solve most of their own problems.

The word processor operator could make my job more difficult by not following the same pattern each time. Procedures for "offer" and "regret" letters could become very unorganized and haphazard if these particular steps were not followed.

Ask me to do work I'm not supposed to do and expect me to drop all priorities. A lot more things could be done on the W.P., but there isn't enough equipment.

They could take the WANG out.

Not give us enough time on word processor.

I need increasingly more WANG time. As the terminals become more booked all the time I could be given insufficient time for my needs.

Time to use W.P. equipment needed.

Train one further on the word processor.

Give me the opportunity or direction to learn the WANG and know that I have access to it for certain times and reasons.

I want the opportunity to be able to learn the extra function of the WANG, such as Mathpack and Decision processing. I operate the WANG on a full time basis, but am one of the ones who have never been on any training programmes.

More training courses, especially on WANG.

## Office B

Support in the work situation: for example, getting me a good terminal. (Director of Sales).

Help from systems analyst on sorting out problems with computer for end of month entries.

Teach me different ways of working with the computer and helping me on various problems. (Computer specialist).

If there are problems with the system (the computer specialists) are very helpful.

(The computer specialist) is very helpful with the system. I call him if I need information and don't know which system to be in.